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10/723,117	11/26/2003	Gang Gu	006161.P001	1307

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EXAMINER

OLSEN, KAJ K

ART UNIT	PAPER NUMBER
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1753

DATE MAILED: 07/12/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

Application No.

10/723,117

Applicant(s)

GU ET AL.

Examiner

Kaj K. Olsen

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 07 April 2005.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 7 and 41-64 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 7, 41-46 and 48-64 is/are rejected.
- 7) ☒ Claim(s) 47 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date \_\_\_\_\_.
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

## DETAILED ACTION

### *Claim Rejections - 35 USC § 112*

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claims 58-64 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. Claims 58-64 are drawn to a method for sensing a specific molecule that comprises the step of measuring a change in a work function of one of the two electrodes. However, the specification does not appear to support this limitation. In particular, the specification teaches monitoring the resistance (or conductance) of the nanoelements across the electrodes and mentions that that resistance is a function of the changing work function (see paragraph 0032). However, applicant does not appear to ever relate back this resistance back to a changing work function. Hence applicant does not ever teach a step of “measuring a change in work function of one of the electrodes” per se. The changing work function might be in part the phenomenological basis for the change in resistance or conductance (although many other factors could contribute to the measured resistance or conductance (see Cui or Dai relied on below for example)), absent any explicit step of measuring a work function or relating the measured resistance back to a work function, this new limitation is not enabled by the originally filed disclosure.

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3. Similarly, applicant also claims measuring the Schottky barrier. Although the applicant discussed altering the Schottky barrier (see paragraph 0041), applicant does not appear to have ever explicitly disclosed measuring a Schottky barrier per se.

***Claim Rejections - 35 USC § 102***

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

5. Claims 46, 48, 50, 53, 54, 56 and 57 are rejected under 35 U.S.C. 102(e) as being anticipated by Dai et al (USP 6,528,020) with evidence by Dijksma et al (Anal. Chem. 2001, 73, pp. 901-907).

6. These claims were previously rejected over Dai with evidence from Dijksma (see the previous final rejection of 1-6-2005). Upon amendment, claim 46 has deleted “layer” and replaced it with --coating--. This would not change the anticipatory nature of Dai because the entire electrode of Dai can be reasonably be construed as being a surface coating giving the claim language its broadest reasonable interpretation. The only scope difference between “layer” and “coating” is the latter implies some process step. However, the electrodes of Dai are presumably coated because they formed in a later stage of sensor construction, and any means to form them would thereby read on coated. In addition, process steps are not germane to the patentability of an apparatus. Nothing in the amended claim 46 states that the electrode must comprise a

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plurality of layers or coatings with an upper surface layer or coating comprising a material with the affinity for bio-molecules. Moreover, even if the examiner were to interpret claim 46 as requiring a plurality of layers or coatings with a coating that has bio-affinity, Dai actually teaches the application of the electrodes as different coatings. See col. 4, ll. 52-56 where titanium is first deposited followed by gold.

7. With respect to claim 50, applicant has amended to state that at least one of the electrodes is not coated. This is because applicant believes col. 3, ll. 18 and 19 evidences that the entire device of Dai is coated including the electrodes. It is unclear how applicant came to such a conclusion. These two lines don't give any indication that the electrodes are coated as well. In fact, the rest of Dai indicates that the coating should only be placed on the nanotubes themselves. Claim 1 states that the sensing agents (of which PMMA is) are to be deposited onto the nanotube. See also col. 2, ll. 54-58, which states that the nanotube itself is to be coated. There is no suggestion by Dai that these films are to be indiscriminately applied over the entire sensor including the electrodes. Because Dai never suggested coating either of the electrodes, and would not have been motivated to do so, the examiner believes Dai still anticipates claim 50.

### ***Claim Rejections - 35 USC § 103***

8. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

9. Claims 7, 41-43 and 45 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cui et al (Science, 293, August 2001, pp. 1289-1292) in view of Krstic et al (Electronic

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Properties of Novel Materials-Molecular Nanostructures, 2000, pp. 367-370) with evidence provided by Heo et al (Applied Physics Letters, 81 (16), 2002, PP. 3046-3048).

10. These claims were previously rejected over Cui in view of Krstic with evidence provided by Heo. Upon amendment, applicant has changed “layer” to --coating--. However, as discussed above with respect to Dai, this does not read free of the examiner’s previous interpretation of “surface layer”. Hence these previous rejections are being maintained here as well.

11. Claims 7, 43 and 44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dai in view of Krstic.

12. Dai set forth all the limitations of the sensor of claim 7 (see rejection above for details), but Dai did not explicitly disclose the presence of a surface layer including Pd. However, as discussed above and in the previous office action, Krstic teaches that alloys of palladium also provide equivalent behavior to that of gold as an electrode. See pp. 368 and 369. It would have been obvious to one of ordinary skill in the art at the time the invention was being made to utilize the teaching of Krstic for the sensor of Dai because the substitution of one known electrode material for another known electrode material requires only routine skill in the art. With respect to the palladium of Krstic constituting a “surface coating including Pd”, any electrode constructed of Pd would inherently have a surface coating comprising Pd. Moreover, Dai already taught that alloyed electrodes can be formed by serial deposition of the components for the electrode. See col. 4, ll. 52-56. Hence, even if the examiner were to interpret “surface coating” as requiring an electrode having a plurality of layers with a surface layer of Pd, one of ordinary skill in the art would have recognized that a Au-Pd alloy can be deposited by serial deposits of Au followed by Pd (or vice versa).

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13. Claims 41, 42 and 45 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dai and Krstic as applied to claim 7 above, and further in view of Cui with evidence by Heo.

14. Claims 51, 52 and 55 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dai in view of Cui with evidence by Heo.

15. With respect to claims 41 and 55, Dai or Dai in view of Krstic set forth all the limitations of the claim, but did not teach the use of a gate electrode disposed between the two electrodes and beneath the nanoelement. As discussed above, Cui shows that the presence of a gate electrode in that set forth position allows one greater control of the sensor behavior. See fig. 1B and p. 1290. With respect to claims 42, 45, 51 and 52, Cui also teaches the equivalence of materials such as silicon nanowires for the sensing device (see fig. 1A). It would have been obvious to one of ordinary skill in the art at the time the invention was being made to utilize the teaching of Cui for the sensor of Dai or Dai in view of Krstic both because a gate electrode allows one greater control of the sensor properties for the sensor and because the substitution of one known nanoelement for another known nanoelement requires only routine skill in the art.

16. With respect to the “inorganic nanorod” of claims 45 and 52, applicant never defines how this element would read away from the more typical terms “nanowire” and “nanotube”. Heo evidences that the term “nanorod” reads on materials that are dimensionally analogous to the nanowires and nanotubes of Cui and Dai (compare Heo abstract with Cui, reference number 15). Hence the claimed nanorods either read on the nanowires and nanotubes of Cui and Dai or are an obvious equivalent thereof.

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17. Claim 44 and (claims 7, 41-43 and 45 in the alternative) are rejected under 35 U.S.C. 103(a) as being unpatentable over Cui and Krstic as applied to claim 43 above, and further in view of Dai.

18. With respect to claim 44, Cui and Krstic set forth all the limitations of the claim, but did not explicitly recite the presence of a network or interconnected nanotubes. Dai teaches that a plurality of nanotubes that are interconnected can also be utilized for establishing the electrical connection. The plurality of tubes has the advantage of being easier to construct than single nanoelement embodiments and also provides greater electrical pathways. See col. 2, ll. 38-47 and col. 4, ll. 5-11. It would have been obvious to one of ordinary skill in the art at the time the invention was being made to utilize the teaching of Dai for the sensor of Cui and Krstic in order to simplify sensor construction and to increase the electrical pathways between the electrodes.

19. With respect to claims 7, 41-43 and 45 in the alternative, the examiner did not believe the claimed "surface coating including Pd" read free of an electrode comprising (presumably) a single layer of AuPd alloy (see discussion above and in the previous final rejection). However, even if the examiner were to interpret "surface coating including Pd" as requiring plural coatings, Dai rendered obvious the process of forming alloyed electrodes by serial deposition of the components of the alloy. See Dai, col. 4, ll. 52-56. It would have been obvious to one of ordinary skill in the art at the time the invention was being made to utilize the teaching of Dai for the deposition steps of the electrode of Cui because serial depositions have been shown to provide a desired electrode alloy.



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20. Claims 46, 48 and 49 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cui in view of Krstic and with or without Dai with evidence by Dijksma et al (Anal. Chem. 2001, 73, 901-907).

21. Cui and Krstic with or without Dai set forth all the limitations of the claims (see previous rejection above). In addition, Krstic taught that an electrode constructed of gold would also have been an obvious choice of electrode material. See the abstract and section titled "Gold (Au)" on pp. 368 and 369. With respect to the broadly claimed surface layer having an affinity for a bio-molecule, gold is known to have an affinity for sulfur containing biomolecules such as cysteine (see abstract of Dijksma). Hence an electrode having gold at the surface would meet the claim limitation. Krstic also teaches combinations of gold and palladium. Although Krstic does not suggest a layer of gold over the palladium, one possessing ordinary skill in the art would recognize utilizing said combination of known metals in those patterns would have required only routine skill in the art (see also the use of Dai above).

22. With respect to the bio-molecule being streptavidin, that is only the intended use of the apparatus and the intended use need not be given further due consideration in determining patentability.

23. Claims 50-57 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cui in view of Dai.

24. With respect to the claims, Cui set forth all the limitations of the claims (see rejections above), but did not explicitly disclose the presence of a protective layer over the nanoelement. As discussed above, such a protective layer is taught by Dai as improving the sensitivity of the sensor for particular constituents. See col. 5, ll. 44-50. It would have been obvious to one of

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ordinary skill in the art at the time the invention was being made to utilize the teaching of Dai for the sensor of Cui in order to improve the sensitivity and selectivity of the sensor.

25. Claims 58-64 are rejected under 35 U.S.C. 102(b) or (e) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over either Cui or Dai with or without the further teaching of Krstic.

26. With respect to these method claims, it is unclear how to interpret them when they are based on a step (i.e. measuring a change in work function of one of the electrodes) that has never been explicitly disclosed by the instant invention (see 112 rejection above). Because both Cui and Dai set forth all the structural elements of the sensor (see rejection above), and because both Cui and Dai are drawn to a sensor where the change in conductance of the sensor is utilized to determine the presence of a specific analyte (like the instant invention), these claims are deemed to be anticipated by or obvious over Cui and Dai. Alternatively, if these method claims are instead interpreted as requiring the presence of an electrode that would be subject to a change in work function upon exposure to a specific analyte, Krstic already rendered obvious the use of an electrode material that the instant invention evidences is subject to a work function change upon exposure to specific gas molecules (i.e. a AuPd alloy). Because it would have been obvious to utilize said alloy as an electrode material for Cui and Dai (see the previous motivation above), these claims would then also be obvious over either Cui or Dai in further view of Krstic.

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***Allowable Subject Matter***

27. Claim 47 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

28. The prior art does not disclose nor render obvious all the limitations of claim 46 and further comprising that the surface layer of the electrode comprise biotin.

***Response to Arguments***

29. Applicant's arguments filed 3-7-2005 have been fully considered but they are not persuasive. Applicant traverses the 112, first paragraph rejection. In particular, applicant urges that paragraph 0032 enables the limitations drawn to measuring a change in work function. However, all paragraph 0032 stated is that a change in current could be related back to an altered work function. Applicant never explicitly disclosed how a measured current could be related back to a change in work function. What equations would one use? How would one account for other factors that can also change the contact resistance? More importantly, applicant never explicitly disclosed doing so. Again claim 58 states "measuring a change in a work function". The examiner reads this claim as an explicit step or steps of actually determining a change in a work function. A mere recognition that a measured change in current *could be* related back to a change in work function (with that supposed relationship between work function and current being unspecified) does not constitute an actual measure of a change in work function. Applicant's arguments concerning measuring the Schottky barrier are similarly unpersuasive.

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Absent a particular recitation of measuring a Schottky barrier, applicant is not enabled for the step of "measuring a Schottky barrier".

30. Applicant's arguments concerning the use of Dai and Cui as primary teachings has been dealt with in the body of the rejection above and will not be reiterated here.

31. With respect to the rejection of claims 58-64, applicant urges that the cited references give no suggestion that the work function changes as a function of the concentration. However, it is not necessary for these references to state the work function would change. The instant invention evidences that electrodes with surface coatings of Au or Pd are subject to work function changes upon exposure to analytes. Because these electrode coatings are known in the art (see all the art rejections above), then these electrodes of the prior art are also subject to work function changes as well.

### ***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kaj Olsen whose telephone number is (571) 272-1344. The examiner can normally be reached on Monday through Thursday from 5:30 A.M. to 3:00 P.M. and on alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam Nguyen, can be reached on 571-272-1342. Until July 15, 2005, the fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306. Starting July 15, 2005, the fax number will be 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

AU 1753  
July 9, 2005

A handwritten signature in black ink, appearing to read 'Kaj K. Olsen', with a long horizontal flourish extending to the right.

**KAJ K. OLSEN**  
**PRIMARY EXAMINER**